

F. Aftertreatment Catalysts Materials Research

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Objective

- Develop knowledge and tools necessary to satisfy the U.S. Environmental Protection Agency (EPA) 2007 and 2010 diesel emissions regulations while minimizing the total cost of ownership.

Approach

- Develop reactors and test methods for understanding the fundamental behavior of catalysts.
- Evaluate novel base metal oxide catalysts for oxidation of diesel soot with conventional and microwave heating.
- Improve understanding of sulfation and desulfation of commercial NO_x reduction catalysts through reactor studies.

Accomplishment

- Completed program final report.

Future Direction

- Continue sulfation and desulfation studies with private funding.
- Continue the search for low-temperature soot oxidation catalysts.

Introduction

The 2007 and 2010 EPA regulations on particulate and NO_x emissions from diesel engines are significantly lower than the current regulatory standards. These regulations are seen as aftertreatment-forcing by the diesel industry.

NO_x traps (also referred to as NO_x storage and release catalysts) are a primary path toward compliance with the 2007 and 2010 EPA regulations.

However, the poisoning effects of sulfur reduce the efficiency of NO_x traps to capture and destroy NO_x emitted from diesel engines. Even though sulfur levels will be reduced in future diesel fuels, any amount of sulfur in fuel will be detrimental because the effect of sulfur on NO_x traps is cumulative. NO_x traps can be desulfated by high-temperature reduction. Desulfation, however, can require extended time at high temperature. If the desulfation process

requires 10 min for completion for light-duty applications, then desulfation will be impractical because the average time between engine start and stop for a light-duty vehicle is less than 10 min.

Catalysts commonly used for soot oxidation in catalyzed soot filters are based on platinum group metals and cerium oxides. The use of platinum group metals significantly increases the cost of catalyst systems. Base metal oxide catalysts, while typically less active than platinum group metal catalysts, are much less expensive. There have been reports in the literature that microwave heating accelerates soot oxidation in the presence of some base metal oxide catalyst more than conventionally heating to a similar temperature accelerates oxidation. If true, this could allow very low temperature regeneration of soot filters, significantly reducing the stress on the system and the cost of regeneration.

Approach

No experimental work was conducted in FY 2005. The program final report was written and submitted to close the program.

Results

The program final report was submitted in February 2005 to close this program.

Summary and Conclusions

A test method was developed that allows a relatively inexpensive mass spectrometer to differentiate between molecules of similar mass and different chemical behavior. Reactors were developed to allow comparison of chemical kinetics with microwave and conventional heating. A reactor for artificial aging of multiple catalyst cores was designed.

Catalyzed soot oxidation with conventional and microwave heating was explored. Data from direct comparisons provided no reasonable basis to think that microwave heating significantly improves catalytic soot oxidation over conventional heating at a similar temperature. Though very low soot oxidation rates were found with some base metal oxide catalysts, these catalysts are very hygroscopic and unlikely to be successful in practical application.

One commercial NO_x adsorber catalyst was evaluated in reactor studies. While other commercial catalysts are expected to have similar qualitative behavior, temperatures required for desulfation will be higher. The temperature at which desulfation rates become reasonable is fairly sharply defined. While desulfation at 500°C removed nearly 80% of the sulfur, desulfation at 475°C failed to remove even 20%. As expected, much of the sulfur removal occurs during the early portion of a desulfation treatment, while a full performance recovery is dependent on removing most of the sulfur.